

Dust Tolerant Electropermanent Magnetic Tool Interface, Phase I

Completed Technology Project (2018 - 2019)



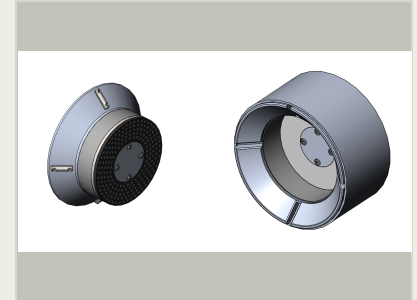
Project Introduction

For many years industrial robots have benefited from the availability of automatic tool changers, allowing one robot to perform a much wider range of tasks than could be performed otherwise. While space robots for satellite servicing have embraced the use of robotic tool changers, planetary science robotics systems have historically avoided the use of tool changers, because traditional tool changers use complex mechanical latching mechanisms with many exposed moving parts, which are often mechanically unreliable in dusty environments. To solve these problems, and enable planetary science missions to switch from using massive, complex, and bulky multi-tool turret designs, Altius proposes the development of an Electropermanent Magnetic Tool Changer, which has no externally exposed moving parts. This proposed EPM Tool Changer concept uses a solid state switchable magnetic latching system to hold the tool to the tool changer, and non-contact power and data transmission. And while it is not in the scope of the proposed Phase I/II effort, this tool changer design can also enable the use of a contactless mechanical tool-drive coupling system, enabling mechanical tool drive without exposed moving parts on either side of the interface.

During Phase I, Altius will work with NASA planetary science robotics teams to identify and document system requirements, and then Altius will design, build, and prototype the magnetic connection system and the wireless power/data transfer systems. This testing, which will include preliminary dusty environment testing will raise the TRL of the power/data version of the EPM tool changer from TRL 2 to TRL 4, enabling a flight-grade prototype of the power/data EPM Tool Changer to be designed, built, and qualified during Phase II, raising the system to TRL 6, where it is mature enough to be integrated into future NASA and commercial missions.

Anticipated Benefits

- Enabling NASA science missions by reducing the size and complexity of robotic manipulators and allowing for analysis and sampling of areas that would be impossible to reach with a traditional multi-tool turret design.
- Enabling lighter-weight robotic tool changers for LEO and GEO satellite servicing applications.



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Magnetic Tool Interface, Phase I

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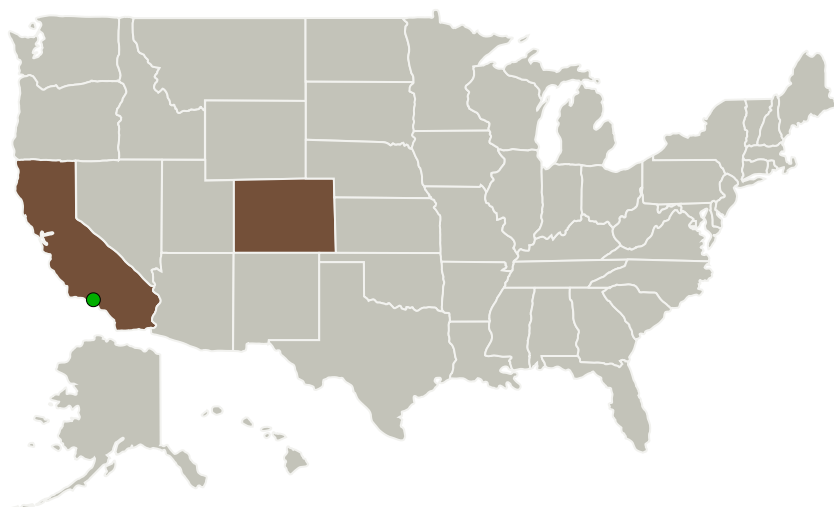
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- Increasing the adaptability of bomb disposal or search and rescue robots that operate in dusty environments
- Enabling hazardous location robotic manipulation such as nuclear reactor cleanup efforts where the hazards require the use of tele-robotics and requires specialized tools and multiple end-effectors.
- Enabling non-hazardous robotic manipulation in dirty or greasy environments.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Altius Space Machines, Inc.	Lead Organization	Industry	Broomfield, Colorado
● Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations

California	Colorado
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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Altius Space Machines, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Joshua Nelson

Co-Investigator:

Joshua Nelson

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Project Transitions

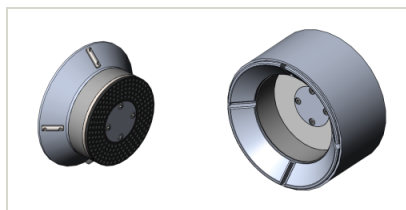
July 2018: Project Start

February 2019: Closed out

Closeout Documentation:

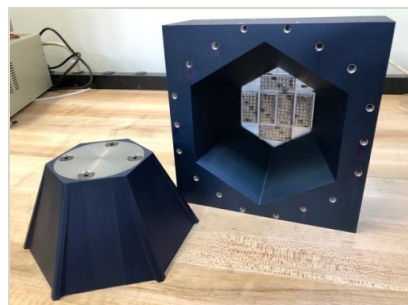
- Final Summary Chart(<https://techport.nasa.gov/file/141021>)

Images



Briefing Chart Image

Dust Tolerant Electropermanent Magnetic Tool Interface, Phase I
(<https://techport.nasa.gov/image/129640>)

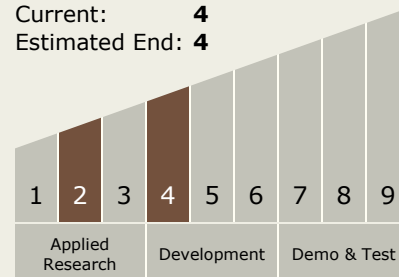


Final Summary Chart Image

Dust Tolerant Electropermanent Magnetic Tool Interface, Phase I
(<https://techport.nasa.gov/image/133596>)

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



Technology Areas

Primary:

- TX04 Robotic Systems
 - TX04.6 Robotics Integration
 - TX04.6.1 Modularity, Commonality, and Interfaces

Target Destinations

Mars, Others Inside the Solar System